

Adapted Lesson Plan by Grace Hu

From: http://www.vernier.com/experiments/elb-wind/11/project_power_up/

Description:

This lab investigation is to inspire students to engineer a wind powered energy source and compare the power output through experimentation by changing the number and pitch of blades, width and length of blades, wind speed and direction. This lab is connected to the energy unit and it's purpose is to make students more aware of the economic versus environmental trade-offs that governments must make in order to implement alternative energy sources such as wind power.

Sustainability is taught through this energy unit as student become educated of the negative environmental costs of harvesting various energy sources for people to use. This theme easily fits into the AP environmental science curriculum because the course is centered around learning about the environment and the environmental impact that humans have on the planet.

The purpose of this lesson is to get students to become 'engineers' and 'policy makers' to plan, build and measure with data the electrical output of their windmill. Getting student to role play and calculate energy output is hands-on, meaningful, and practical. This lesson is adapted to use for the AP environmental science level and will involve the use of wind turbine kit to collect, compare and wind energy output. The students will also apply their knowledge about alternative energy to a hypothetical town which has to choose which type of alternative energy source makes the most sense.

In terms of my own professional goals, my classroom was given a mobile STEM lab which included engineering kits such as a wind turbine kit. Personally, I haven't had the time or proper professional development to implement these kits into classroom instruction. By planning this lesson, I hope to learn how to use the turbine kit myself, and get students engineering and planning meaningful lab activities in order to maximize student engagement.

Grade Level:

12th grade AP environmental science. Prerequisites include previously passing Regents living environment, Regents chemistry and / or Regents earth science.

Topic:

Energy Resource and Consumption -Subunit: alternative energy sources -Topic: Summative assessment as a case study lab report.

Time:

5 period classes. 1) Introduction and planning 2) Building and Experimenting 3) Data collection 4) Data Analysis 5) Project report and Mini Presentation

Standards:

Student Standards

- AP Enviro Sci V. Energy Resources and Consumption G. Renewable Energy
- NGSS HSPS 3.3 Design, build, refine a device that works within given constraints to convert one form of energy into another form of energy

Teacher Standards

- Danielson 3c. Engaging Students in Learning

Objectives:

- Student will work in small groups to **plan the design** of their wind turbine in terms of number of blades, length of blades and any other important information

- **Investigate** power output from their own wind turbine
- **Analyze** energy data and **compare** energy output to other alternative energy source
- **Evaluate** the pros and cons of wind energy **compared** to hydroelectric and fossil fuels

Procedures / Methods

Day 1

Student Agenda

Aim: Introducing the Windy Gap case study and Initial plan to build a wind turbine

Do Now: Sit with your assigned group, read over the introduction to the case study, create a t-list of the advantages and disadvantages of wind power versus hydroelectric power (15 minutes)

Mini Lesson: The constraints, objectives and parts of the wind turbine (10 minutes)

Work Period: Plan the initial design -create a poster -include the team name (20 minutes)

Closing: share-out your initial design plan with classmates (5 minutes)

Teaching Notes

Before the lesson:

- Put students in heterogenous level groups of 3 to 4 students per group
- Print out copies of the case study. The case study can be found at:
http://www.vernier.com/files/sample_labs/ELB-WIND-11-project_power_up.pdf
- Set-out markers, 2 pieces of chart paper for each group
- Double-check all parts of the wind turbine kit are present in full working order

Day 2

Student Agenda

Aim: Engineering and putting together wind turbines

Do Now: Gather equipment and determine the purpose of each part (5 minutes)

Mini Lesson: Sensor Data Collection and Organization (10 minutes)

Work Period: In your experiment journals, record your data, what steps you took, what alterations from the original plan that you took (20 minutes)

Closing: Share-out the final most optimized design for your wind turbine (10 minutes)

Teaching Notes:

Before the lesson:

- Check the equipment for each kit works
- Remind students of their data journal entries should include all stages and data organization
- Have enough time to share out at the closing

During the lesson:

- Circulate the classroom having mini-conferences with each group

Day 3

Student Agenda

Aim: Data Collection and Optimization for each group

Do Now: What alternative hypothesis for optimizing wind power do you want to test? (10 minutes)

Mini Lesson: Continue data collection (2 minutes)

Work Period: Data collection and retesting (25 minutes)

Closing: Share-out the best class results on a chart paper have students write it down (5 minutes)

Teacher Agenda

- Before the lesson, this link provides guides on experiment variable that each group could test out: http://www.ecostyle.co.uk/lesson_plans.html -look under wind turbines

During the lesson:

- Circulate the classroom having mini-conferences with each group
- Remind students to sketch and record any changes that they have made

Day 4

Student Agenda

Aim: How do we present the data clearly?

Do Now: Read the graph choice chart

Mini Lesson: What type of graph do you think you will make?

Work Period: Using laptops, google sheets, tabulate your results in a data table & graph it using the right type of graph

Closing: Exit Slip...what do you still need clarification about in terms of presenting data?

Teacher Agenda

Before the lesson:

- Print graph choice chart. <https://drive.google.com/open?id=0B8-MNYcl5allUFJybldERktVelk>
- Book out the laptop cart

Notes:

- Allow enough days between this last day of data collection and the oral defense for students to work on it at home (two days minimum - to a week)

Day 5 (maybe 6 if you have a lot of groups)

Student Agenda

Aim: Wind turbine Oral Defense

Do Now: Determine presentation order

Mini Lesson: All groups members must participate

Work Period: Presentations -have students peer assess & ask questions to other groups

Closing: Share out comments and conclusions of the activity. Exit-slip -what did the students enjoy about the activity?

Teacher Agenda

Before the lesson:

- Print out the rubric -make sure the students are aware of the expectations <https://drive.google.com/open?id=0B8-MNYcl5alleEo4clNpOEdocFk>
- Have technology available for the presentations

Other Useful Background References:

<http://energy.gov/eere/wind/how-do-wind-turbines-work>

This link provides background information and vocabulary of general wind turbines

http://www.ecostyle.co.uk/lesson_plans.html

This link has additional lesson plan ideas using the wind turbine kit